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(54) **LASER FUSEBLOW PROTECTION METHOD FOR SILICON ON INSULATOR (SOI) TRANSISTORS**

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(58) **Field of Search** ..... 438/132, 215, 438/281, 333, 467, 601; 365/72, 175

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

5,986,862	A	11/1999	Kim	
6,043,609	A	* 3/2000	George et al.	315/169.3
6,112,275	A	* 8/2000	Curry et al.	711/100
6,246,625	B1	* 6/2001	Yamagata et al.	365/226
6,262,919	B1	7/2001	Chou	

**OTHER PUBLICATIONS**

Effect of Protection Diodes on the Behavior of CMOS Gates in the presence of Supply Dips Hassanein H. Amer Canadian Conference of Electrical and Computer Engineering 1997 IEEE 1997 pp. 536-539 vol. 2.\*

PROM Fuse Design Scales to sub-0.25 micron Gail Robinson Electronic Engineering Times Sep. 29, 1997 p. 44.\*

\* cited by examiner

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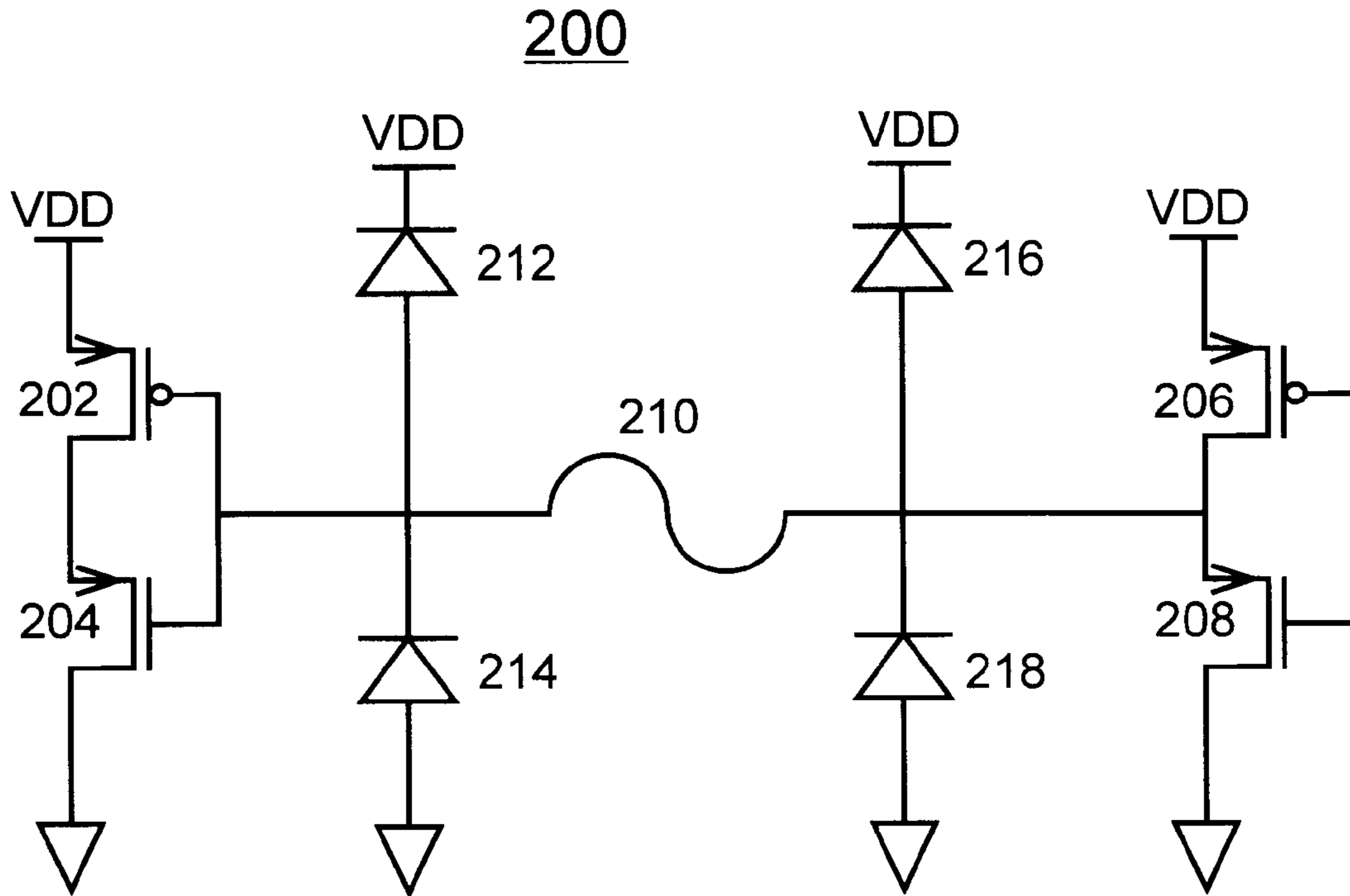
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(57) **ABSTRACT**

A method and apparatus are provided for laser fuseblow protection in transistors, such as silicon-on-insulator (SOI) transistors. The transistors are connected to a fuse. A pair of diodes are connected in series between a high supply and ground. A common connection of the series connected pair of diodes is connected to a common connection of the fuse and transistors. A charge is shunted to the high supply or ground by the pair of diodes with a first voltage a set value above the high supply and a second voltage a set value below the ground. A pair of protection diodes are provided on each side of the fuse with transistors. The transistors are either connected to one side of the fuse or to both sides of the fuse.

**9 Claims, 3 Drawing Sheets**



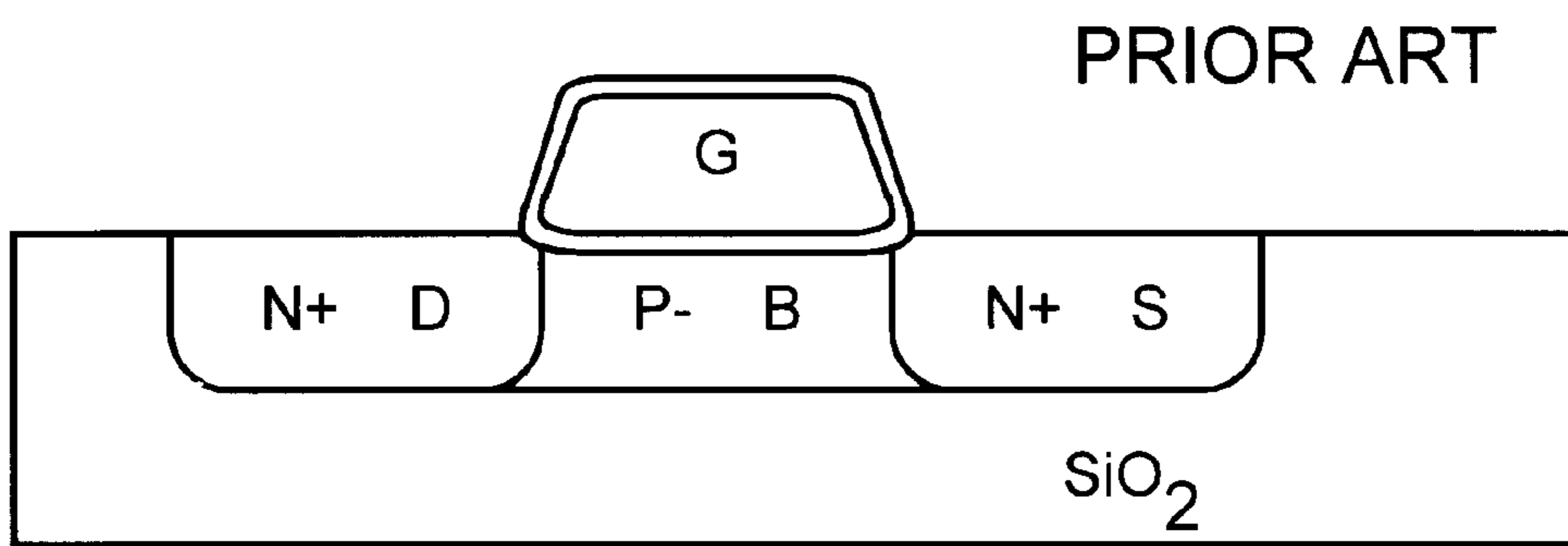


FIG. 1

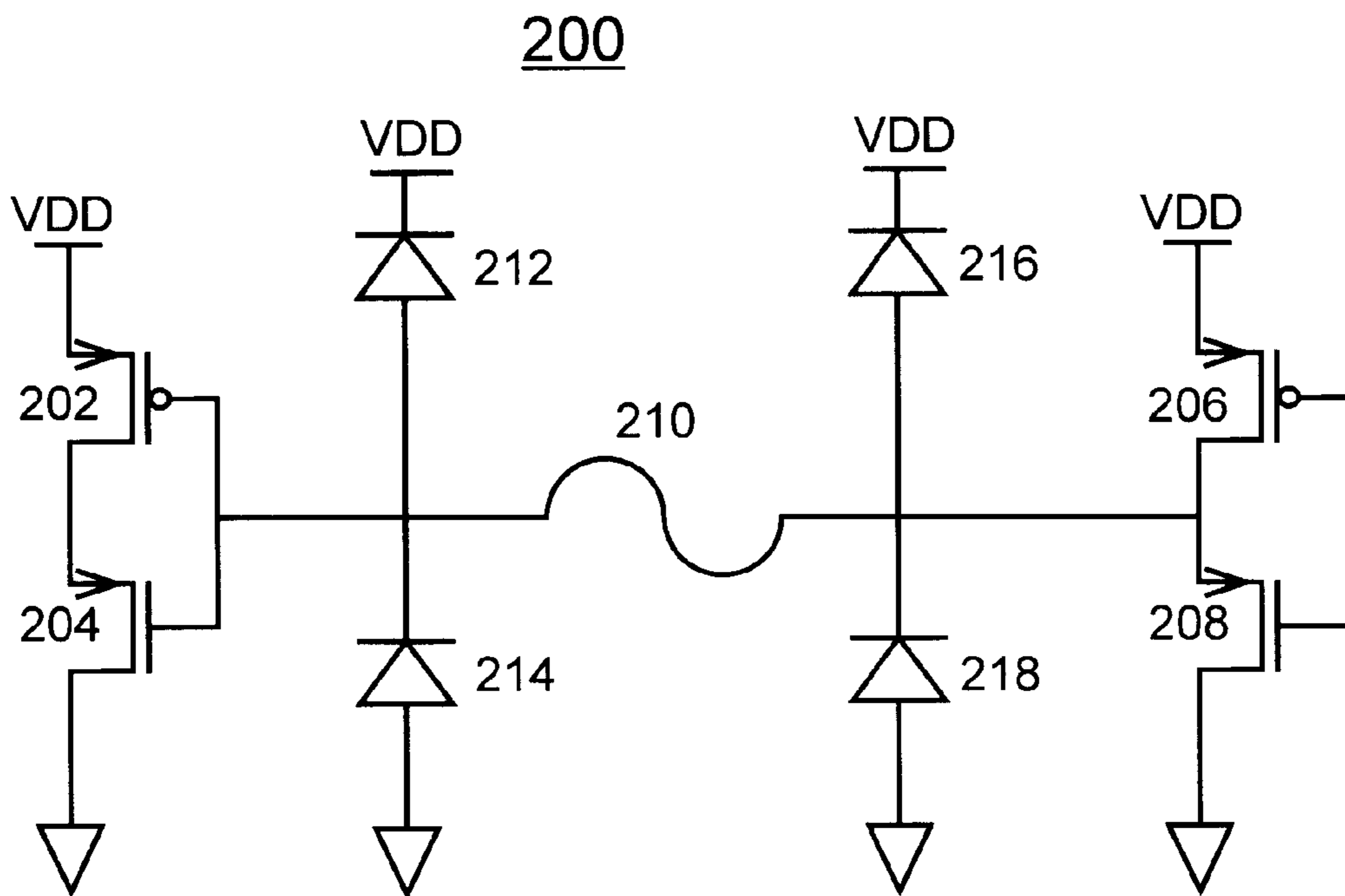


FIG. 2

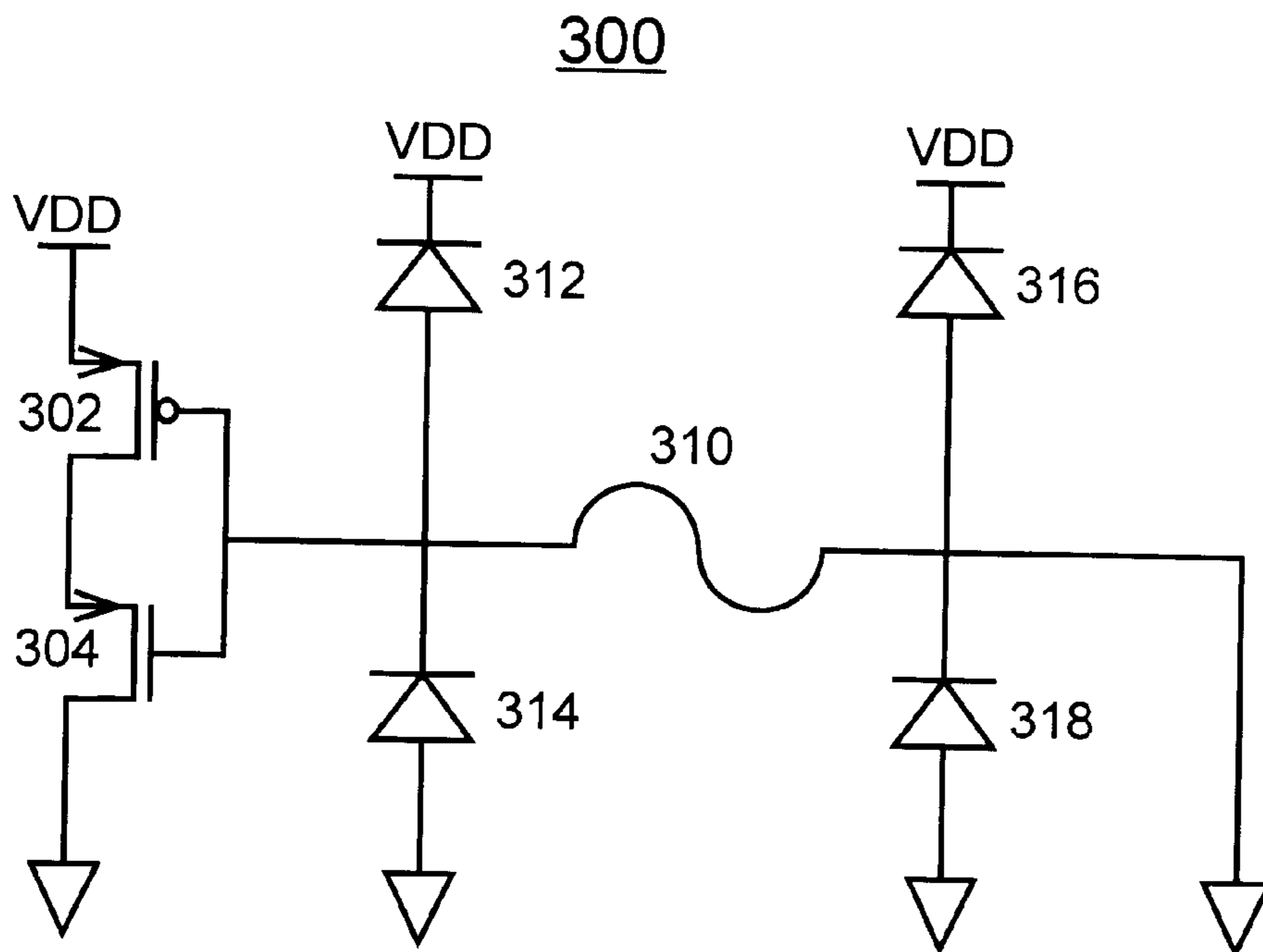


FIG. 3



## LASER FUSEBLOW PROTECTION METHOD FOR SILICON ON INSULATOR (SOI) TRANSISTORS

### FIELD OF THE INVENTION

The present invention relates to a method and apparatus for laser fuseblow protection in silicon-on-insulator (SOI) transistors.

### DESCRIPTION OF THE RELATED ART

Silicon-on-insulator (SOI) technology is an enhanced silicon technology currently being utilized to increase the performance of digital logic circuits. Utilizing SOI technology designers can increase the speed of digital logic integrated circuits while reducing their overall power consumption. These advances in technology will lead to the development of more complex and faster computer integrated circuits that operate with less power.

As shown in FIG. 1, SOI semiconductors include a thin layer of silicon placed on top of an insulator, such as silicon dioxide (SiO<sub>2</sub>) or glass, and a MOS transistor built on top of this structure. The SOI FET includes a body (B), a gate (G), a drain (D) and a source (S). The main advantage of constructing the MOS transistor on top of an insulator layer is to reduce the internal capacitance of the transistor. This is accomplished by placing the insulator oxide layer between the silicon substrate and the impurities required for the device to operate as a transistor. Reducing the internal capacitance of the transistor increases its operating speed. With SOI technology faster MOS transistors can be manufactured resulting in higher performance semiconductors for faster electronic devices.

In a conventional, bulk silicon process, the transistors are built in the top surface of a relatively thick mass of silicon. During a laser fuseblow process, energy that is imparted to the transistors has this thick silicon in which to dissipate this energy. SOI transistors are built on the thin layer of silicon placed on top of a thicker insulator as shown in FIG. 1. Damage to the SOI transistor devices can occur due to the decreased ability to dissipate the resulting charge build up from the laser fuseblow process in the thin layer of silicon.

A need exists for a mechanism for protecting SOI transistors from an excess voltage and charge that can be built up during a laser fuseblow process.

### SUMMARY OF THE INVENTION

A principal object of the present invention is to provide a method and apparatus for laser fuseblow protection in silicon-on-insulator (SOI) transistors. Other important objects of the present invention are to provide such a method and apparatus for laser fuseblow protection in silicon-on-insulator (SOI) transistors substantially without negative effect and that overcome many of the disadvantages of prior art arrangements.

In brief, a method and apparatus are provided for laser fuseblow protection in transistors, such as silicon-on-insulator (SOI) transistors. The transistors are connected to a fuse. A pair of diodes are connected in series between a high supply and ground. A common connection of the series connected pair of diodes is connected to a common connection of the fuse and transistors. A charge is shunted to the high supply or ground by the pair of diodes with a first voltage a set value above the high supply and a second voltage a set value below the ground.

In accordance with features of the invention, a pair of protection diodes are provided on each side of the fuse with transistors. The transistors are either connected to one side of the fuse or to both sides of the fuse.

### BRIEF DESCRIPTION OF THE DRAWINGS

The present invention together with the above and other objects and advantages may best be understood from the following detailed description of the preferred embodiments of the invention illustrated in the drawings, wherein:

FIG. 1 is a cross sectional view illustrating a conventional silicon-on-insulator (SOI) N-channel field effect transistor (NFET);

FIG. 2 is a schematic diagram illustrating apparatus for laser fuseblow protection in silicon-on-insulator (SOI) transistors in accordance with the preferred embodiment; and

FIG. 3 is a schematic diagram illustrating another apparatus for laser fuseblow protection in silicon-on-insulator (SOI) transistors in accordance with the preferred embodiment.

### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Having reference now to the drawings, in FIG. 2, there is shown apparatus for laser fuseblow protection in silicon-on-insulator (SOI) transistors of the preferred embodiment generally designated by the reference character 200. As shown in FIG. 2, a plurality of SOI transistors 202, 204, 206 and 208 are directly connected to a fuse 210. It should be understood that the principles of the present invention are not limited to silicon-on-insulator (SOI) transistors and can be used with other types of transistors, such as conventional, bulk silicon transistor devices.

In very large scale integrated (VLSI) chips, it is common to have fuses, such as fuse 210 that can be programmed for various reasons. Among these reasons include invoking redundant elements in memory arrays for repairing failing locations or programming identification information. A common method of building and programming such fuses 210 is to build a thin metal wire fuse near the top surface of the chip. The fuse 210 can be programmed by selectively deleting the thin metal using a laser (not shown). The thin wire is connected to a circuit that can sense whether the fuse remains or has been deleted. The laser imparts energy that vaporizes the metal to create an open circuit. The circuit that senses the presence or absence of a fuse 210 must be able to withstand the energy of the laser fuseblow process.

In accordance with features of the preferred embodiment, the problem of protecting the SOI transistors 202, 204, 206 and 208 connected to fuse 210 to withstand the energy of the laser fuseblow process is solved by a plurality of protection diodes 212, 214, 216 and 218. Protection diodes 212, 214, 216 and 218 of the preferred embodiment are designed for protecting the SOI transistors 202, 204, 206 and 208 directly connected to fuse 210.

There are many designs or arrangements for sensing whether a fuse 210 has been blown or not. In all cases transistors are directly connected to fuse 210 either on one side or both sides of the fuse and are prone to damage. In FIG. 2, the SOI transistors 202, 204, 206 and 208 directly connected to fuse 210 are protected respectively by protection diodes 212, 214, 216 and 218. Protection diodes 212 and 214 and protection diodes 216 and 218 are connected in series between the high supply VDD and ground. As shown in FIG. 2, a cathode of diodes 212, 216 is connected to the



high supply and an anode of diodes **212, 216** is connected respectively to a cathode of diodes **214, 218** with an anode of diodes **214, 218** connected to ground. A common connection of the series connected protection diodes **212** and **214** is connected to the common connection of fuse **210** and SOI transistors **202** and **204**. A common connection of the series connected protection diodes **216** and **218** is connected to the common connection of fuse **210** and SOI transistors **206** and **208**.

By designing the protection diodes **212, 214, 216** and **218** to each power supply on each side of the fuse **210** with transistors **202** and **204**, and transistors **206** and **208**, the transistors **202, 204, 206** and **208** are protected from the otherwise destructive voltages that could damage them. The protection diodes **212, 214, 216** and **218** will shunt the charge to either the ground or high supply if the voltage rises above a diode threshold voltage or around 0.7 Volt above the high supply or drops lower than 0.7 Volt below the ground supply. Transistors are typically designed to withstand these voltages that are only 0.7 Volt above or below typical or expected values during functional operation.

Referring to FIG. **3**, there is shown another apparatus for laser fuseblow protection in silicon-on-insulator (SOI) transistors of the preferred embodiment generally designated by the reference character **300**. As shown in FIG. **3**, a pair of SOI transistors **302, 304** are directly connected to one side of a fuse **310**. The other side of fuse **310** is connected to ground. Protecting the SOI transistors **302** and **304** connected to fuse **310** to withstand the energy of the laser fuseblow process is solved by a plurality of protection diodes **312, 314, 316** and **318**. Protection diodes **312** and **314** and protection diodes **316** and **318** are connected in series between the high supply VDD and ground. As shown in FIG. **3**, a cathode of diodes **312, 316** is connected to the high supply and an anode of diodes **312, 316** is connected respectively to a cathode of diodes **314, 318** with an anode of diodes **314, 318** connected to ground. A common connection of the series connected protection diodes **312** and **314** is connected to the common connection of fuse **310** and SOI transistors **302** and **304**. A common connection of the series connected protection diodes **316** and **318** is connected to the common connection of fuse **310** and ground.

By designing the protection diodes **312, 314, 316** and **318** to each power supply on each side of the fuse **310** with transistors **302** and **304**, the transistors **302** and **304** are protected from the otherwise destructive voltages that could damage them. The protection diodes **312, 314, 316** and **318** will shunt the charge to either the ground or high supply if the voltage rises above a diode threshold voltage or around 0.7 Volt above the high supply or drops lower than 0.7 Volt below the ground supply.

While the present invention has been described with reference to the details of the embodiments of the invention shown in the drawing, these details are not intended to limit the scope of the invention as claimed in the appended claims.

What is claimed is:

1. A method for laser fuseblow protection in transistors directly connected to a fuse comprising the steps of:
  - providing a pair of diodes connected in series between a high power supply and ground;
  - directly connecting a common connection of said series connected pair of diodes to a connection of the fuse and transistors; and

shunting a charge to said high power supply or ground by said pair of diodes with a first voltage a set value above said high power supply and a second voltage a set value below said ground.

2. A method for laser fuseblow protection in transistors directly connected to a fuse as recited in claim **1** wherein the transistors include silicon-on-insulator (SOI) transistors.

3. A method for laser fuseblow protection in transistors directly connected to a fuse as recited in claim **1** further includes the steps of providing a second pair of diodes connected in series between said high power supply and ground; and directly connecting a common connection of said series connected pair of diodes to a connection of the fuse and ground.

4. A method for laser fuseblow protection in transistors directly connected to a fuse as recited in claim **1** wherein the step of providing a pair of diodes connected in series between said high power supply and ground includes the step of connecting a cathode of a first diode of said pair of diodes to said high supply and an anode to a cathode of a second diode of said pair of diodes and connecting an anode of said second diode to ground.

5. A method for laser fuseblow protection in transistors directly connected to a fuse as recited in claim **1** wherein the step of shunting a charge to said high power supply or ground by said pair of diodes with a first voltage a set value above said high power supply and a second voltage a set value below said ground includes the step of shunting a charge to said high power supply or ground by said pair of diodes with a first voltage about 0.7 Volt above said high power supply and a second voltage about 0.7 Volt below said ground.

6. A method for laser fuseblow protection in transistors directly connected to a fuse comprising the steps of:

providing a first pair of diodes connected in series between a high power supply and ground;

directly connecting a common connection of said series connected first pair of diodes to a connection of the fuse and transistors;

shunting a charge to said high power supply or ground by said first pair of diodes with a first voltage a set value above said high power supply and a second voltage a set value below said ground;

providing a second pair of diodes connected in series between a high supply and ground; and

directly connecting a common connection of said series connected second pair of diodes to a second side of the fuse.

7. A method for laser fuseblow protection in transistors directly connected to a fuse as recited in claim **6** further includes the step of connecting said second side of the fuse to ground.

8. A method for laser fuseblow protection in transistors directly connected to a fuse as recited in claim **6** further includes the step of directly connecting second transistors to said common connection of said series connected second pair of diodes and said second side of the fuse.

9. A method for laser fuseblow protection in transistors directly connected to a fuse as recited in claim **6** further includes the step of using the transistors directly connected to the fuse for sensing the presence or absence of the fuse.